Optimal Capital Regulation with Two Banking Sectors

Taejin Kim and Vishal Mangla

Northwestern University

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Question

- What capital regulation policy achieves the optimal systemic risk exposure when banks **can choose to be unregulated**?

Why do we care?

- Financial intermediaries engage in regulatory arbitrage
  - Too stringent policy⇒FIs move outside the regulation umbrella.
    - Example: Widespread growth of SIVs, SPVs etc before the crisis of 2007-2009.
  - Too lenient policy⇒FIs accept being regulated and enjoy the accompanying government support.
    - Example: Goldman Sachs and Morgan Stanley acquire the status of bank holding company during the crisis
- Effective policy design requires government to consider this strategic behavior of FIs.

What do we find?

- The optimal capital regulation policy is **procyclical**:
  - Loose capital requirement during good times and vice versa.
  - This is opposite to the *counter-cyclical* policy suggested in the literature.
- Argument in the literature:
  - Higher capital requirement during good times limits the risk banks can take.
  - Lower capital requirement during bad times avoids forcing banks to cut credit/fire sell in order to maintain their capital ratio.
- Literature ignores the strategic behavior of banks.

Intuition of our result

- Banks compare benefit and cost of being regulated
  - Benefit: Access to cheaper financing due to deposit insurance
  - Cost: Limit on risk exposure of the asset portfolio
- During good times, looser capital requirement⇒banks prefer to be regulated⇒systemic risk is controlled.
- During bad times, tighter capital requirement⇒banks move to shadow banking sector and take risk⇒not too conservative investments.

Other features of our regulation policy

1. Macro-prudential
2. Market-based
3. Robust to business cycle fluctuations
4. Robust to small measurement errors

Setup

- Two dates: $t = 0, 1$
- Assets
  - Risky (return $\tilde{R}$) and Risk-free (return unity)
  - returns are realized at $t = 1$
  - $\mu \equiv E[\tilde{R}]$ and $\sigma \equiv std[\tilde{R}]$ pin down distribution of $\tilde{R}$
  - $F^{\mu,\sigma}(\tilde{R})$ belong to one location-scale family
- Investors
  - measure W, risk averse with utility $u(\cdot)$, each has unit wealth
  - no direct access to assets, can invest only in one bank
- Banks
  - measure 1, risk neutral, each has own capital k distributed according to G (no other heterogeneity)
  - If d is raised from investors and β fraction of wealth is invested in the risky asset, the return is

$$\beta(k+d)\tilde{R} + (1-\beta)(k+d)$$

Setup (cont'd)

Regulator

- Objective: Achieve optimal systemic risk exposure
  - Equivalent to obtaining the optimal fraction (denoted $\phi(\mu, \sigma)$) of the aggregate wealth invested in the risky asset
  - $\phi(\mu, \sigma)$ maximizes the investors' utility over aggregate return: $\max_\phi \mathbb{E}u(1 + \phi(\tilde{R} - 1))$. E.g. $\phi(\mu, \sigma) = \frac{\mu - 1}{\gamma\sigma^2}$ for CRRA(γ)
  - Assumes that investors are the ultimate owners of the banks
- Regulation: Control banks' risk leverage
  - A regulated (commercial) bank has to satisfy
    - standard deviation of the bank's portfolio return $\leq \lambda k$
  - Regulated banks get (free) deposit insurance
  - λ is the policy instrument (capital requirement)

Four Steps of Analysis

1. Solve the contracting problem between an unregulated (shadow) bank and its investors.
   - The corresponding problem for regulated bank is trivial.
2. Find the condition for the banks to be indifferent between being regulated and unregulated in equilibrium.
3. Find the condition on relative size of the two banking sectors such that aggregate risk exposure is optimal.
4. Tie conditions in steps 2 and 3 to obtain the optimal regulation schedule.

Step 1: Contract between Shadow Banks and Investors

- Contract on shadow banks' (SB) investment return
- Debt contract is optimal
- Assume the banks have the whole bargaining power
  - A bank with total assets to liability ratio $s(k)$ offers a take-it-or-leave-it interest rate $r(k)$ to investors
  - Under REE, mass of investors that lend this SB is such that the total assets to liability ratio is actually $s(k)$
- Equilibrium $r(\cdot)$ and $s(\cdot)$ are solution to the program:

$$\max_{r(\cdot)>1, s(\cdot)>1} \mathbb{E} \max \left\{ \frac{ks(k)}{s(k)-1} \tilde{R} - \frac{k}{s(k)-1} r(k), 0 \right\} \tag{1}$$

$$\text{s.t. } \mathbb{E} u \left(\min \left\{ r(k), s(k) \tilde{R} \right\} \right) = u(1) \tag{2}$$

Contract between Shadow Banks and Investors (cont'd)

- *Lemma*: Functions $r(\cdot)$ and $s(\cdot)$ are constant functions
- Thus, the optimization problem is simplified to

$$\max_{r,s} \; k\Pi(r,s) \text{ subject to } s = s^u(r)$$

- Assume $\mathbb{E}u(\tilde{R}) < u(1)$
  - Keeps banks from borrowing infinite debt with a finite r
  - Equivalent to a lower bound on risk aversion

Proposition

The solution (r^*, s^*) to the contracting problem exists and is unique.

(r^*, s^*) is the unique point of tangency between investors' participation constraint curve $s^u(r)$ and shadow bank's iso-profit curve $\Pi(r,s) = \overline{\Pi}$ (for some $\overline{\Pi}$).

Step 2: Banks' Choice: Commercial vs. Shadow

- Commercial banks (CB) maximize invesment in the risky asset

$$\text{std}\left[\beta(k+d)\tilde{R} + (1-\beta)(k+d)\right] = \lambda k$$

- CB's investment in the risky asset is $\beta(k+d) = \frac{\lambda}{\sigma}k$
  - "Effective" asset to liability ratio, $s = \frac{\frac{\lambda}{\sigma}k}{\frac{\lambda}{\sigma}k - k} = \frac{\lambda}{\lambda - \sigma}$
- CB's expected profit is $k\Pi\left(1, \frac{\lambda}{\lambda-\sigma}\right)$
- So, a bank chooses its type irrespective of k according to

$$\begin{array}{ll} \text{If } \Pi(1, \frac{\lambda}{\lambda-\sigma}; \mu, \sigma) > \Pi(r^*, s^*; \mu, \sigma), & \text{CB} \\ \text{If } \Pi(1, \frac{\lambda}{\lambda-\sigma}; \mu, \sigma) < \Pi(r^*, s^*; \mu, \sigma), & \text{SB} \\ \text{If } \Pi(1, \frac{\lambda}{\lambda-\sigma}; \mu, \sigma) = \Pi(r^*, s^*; \mu, \sigma), & \text{indifferent} \end{array}$$

Indifference

- We focus on the case in which both types of banks exist in the banking sector (interior solution)
  - All banks are indifferent between being SB and CB
- Fix $\sigma = 1$
- $\Pi(1, \frac{\lambda}{\lambda-1}; \mu, 1) = \Pi(r^*, s^*; \mu, 1) \Longrightarrow \lambda = \Gamma(\mu)$
- What is the effect of changing μ?

Spence-Mirrlees Condition

Claim 1

If

$$\frac{1 - F(r/s)}{f(r/s)} > \frac{\int_{r/s}^{\infty} (1 - F(R))\, dR}{1 - F(r/s)},$$

then $\Pi(r, s; \mu)$ satisfies the strict Spence-Mirrlees condition.

- Milgrom and Shannon (1994), Edlin and Shannon (1998 a,b)

Claim 2

The above condition is satisfied if hazard rate is increasing in R.

- Increasing hazard rate is a sufficient condition.
- A standard assumption in mechanism design literature

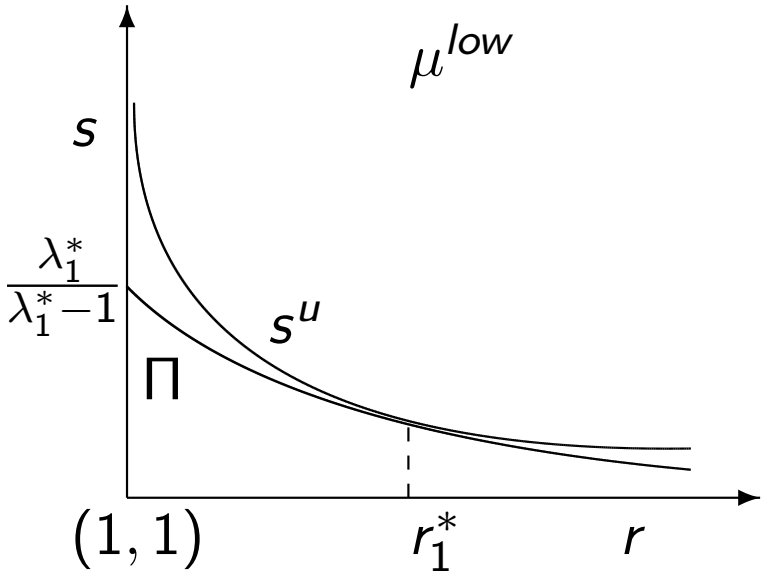
Procyclical Regulation

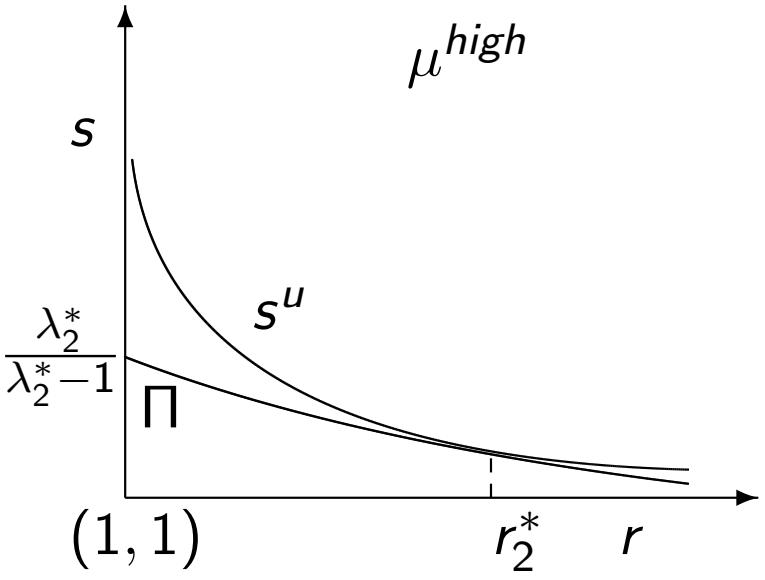
Proposition

Under the above condition, the equilibrium regulation is procyclical: $\Gamma'(\mu) > 0$.

- When μ is high, being SB becomes more attractive.
- To maintain the indifference, the regulation should be relaxed (by increasing λ) to increase the profitability of CB.
- Otherwise, excessive capital flows toward SB takes place.

Procyclical Regulation (cont'd)





$$\lambda_2^* > \lambda_1^*$$

Step 3: Optimal Relative Banking Sector Size

- Regulator wants to achieve $\phi(\mu)$ fraction in the risky asset
  - Recall $\phi(\mu) = \text{argmax}_{\phi} \mathbb{E} u(1 + \phi(\tilde{R} - 1))$
- Total Assets/Equity (leverage) for SB, $l \equiv \frac{s}{s-1}$; λ for CB
- Relative sector size: $\xi \equiv \int_{SB} kdG / \int_{CB} kdG$ and $K \equiv \int kdG$
- Aggregate investment in the risky asset: $l \int_{SB} kdG + \lambda \int_{CB} kdG = \frac{K}{\xi+1} [l\xi + \lambda]$
- Optimal regulation equates the equilibrium fraction in the risky asset to the target fraction

$$\frac{w(l\xi + \lambda)}{\xi + 1} = \phi(\mu) \Longrightarrow \mu = h(\xi)$$

where we assume $w \equiv K/(W + K) \ll 1$.

Step 4: Optimal Policy Schedule

- Combine the following two conditions:
  1. Banks' indifference condition: $\lambda = \Gamma(\mu)$
  2. Optimal relative banking sector size: $\xi = h^{-1}(\mu)$

  to obtain the regulation policy $\lambda = \Gamma(h(\xi)) \equiv \Omega(\xi)$.
- Regulator announces the schedule $\Omega(\cdot)$ instead of a specific λ.
- ξ is easy to observe in data compared to μ, etc.
- In equilibrium, $\phi(\mu)$ is always achieved irrespective of the economic condition, μ.

Optimal Policy Schedule (cont'd)

Proposition

The regulation policy is stable: $\Omega'(\xi) > 0$.

- Stable banking sector equilibrium
  - If there are more SBs than under equilibrium, ξ goes up
  - $\Rightarrow \lambda = \Omega(\xi)$ goes up
  - $\Rightarrow$ Being CB is more profitable – SBs start switching to CB
  - Banks move to SB until it is no more profitable, and equilibrium is achieved
- Robust to business cycle fluctuation
  - If μ goes up to μ', then $\lambda = \Omega(\xi) = \Gamma(\mu) < \Gamma(\mu')$
  - $\Rightarrow$ Being SB is more profitable – CBs start switching to SB
  - $\Rightarrow \xi$ goes up implying $\lambda = \Omega(\xi)$ goes up
  - Feedback loop stops when the new λ has increased to $\lambda' = \Gamma(\mu')$.

Features of the Regulation Policy: $\Omega(\cdot)$

- Macro-prudential
  - The objective of the policy is to control systemic risk (rather than focusing on health of each individual bank).
- Market-based
  - Once the policy schedule is announced, market self-adjusts to obtain the optimal risk exposure.
  - No bank has incentive to deviate from the market equilibrium.
  - Regulator does not need to estimate the underlying economic fundamentals itself.
- Robust to business cycle fluctuations
  - Under the policy, economy transitions smoothly from one equilibrium to another as the underlying fundamentals change.
- Robust to small measurement errors
  - Small measurement errors lead to welfare loss that is an order smaller.

Alternative Implementation?

- What if the regulator knows the economic fundamental μ?
- Even if the regulator knows μ accurately (or has the same belief as agents), the optimal risk exposure is not achieved by implementing $\lambda = \Gamma(\mu)$
  - This only ensures banks' indifference between SB and CB.
  - This leaves aggregate risk exposure indeterminate.
- Moreover, implementing $\lambda = \Gamma(\mu)$ is very susceptible to specification error.
- In contrast, $\Omega(\xi)$ is robust to errors: $|\Omega(\xi) - \Omega^n(\xi)| = O(\varepsilon), \forall \xi \Rightarrow |EU^* - EU^n| = O(\varepsilon^2)$.

Extension: Dynamic Environment

- Repeat the one-period economy.
  - Assume one-period contracts are written at the beginning of every period.
- w_t is the state variable
  - Determined by outcome of the risky return realization over the last period $\tilde{R}_t$ and the earlier information $\mathcal{F}_{t-1}$.
  - Optimal relative sector size is now $\xi(\mu_t; w_t)$ with $\xi_\mu > 0$
  - Optimal regulation is now $\lambda_t = \Omega(\xi_t; w_t)$ with $\Omega_\xi > 0$
  - Banks' indifference condition is still $\lambda_t = \Gamma(\mu_t)$ with $\Gamma' > 0$ – procyclical regulation.
- In the traditional setup, there is no SB sector – $\xi = 0$.
  - This yields the regulation $\lambda_t = \phi(\mu_t)/w_t$
  - If λ_t were fixed, bank lending $\lambda_t w_t$ would shrink more than profitable investment opportunity $\phi(\mu_t)$ in recessions and vice versa in booms (Kashyap & Stein (2004))
  - Hence, λ_t should be raised during bad times and vice versa – counter-cyclical policy

Empirical Predictions

1. The relative size of the shadow banking sector wrt that of the commercial banking sector is procyclical when the capital requirement is held fixed.
2. The leverage of the shadow banking sector is procyclical.
3. Shadow banks offer procyclical interest rate to their investors.

- The first two predictions find support in data.

Philosophy of our regulation policy

- 'Right' mix of the two banking sectors
  - Achieves the optimal risk exposure by obtaining the right mix of the risky shadow banking sector and the safe commercial banking sector.
- Some banks will always exist in shadows
  - Rather than the overarching ambition of regulating everyone, our policy only indirectly influences the size of SB sector to control systemic risk.

Are counter-cyclical regulation policies wrong?

- In this paper, we model one economic force not discussed in the literature that warrants procyclical policy.
- We have mostly ignored the forces that justify counter-cyclical policy.
  - For e.g., absent the recent financial innovations that facilitate capital flow between SB and CB, our argument does not hold.
- Possibly there is some balance between those forces for the optimal regulation.

Summary

- We model the decision of banks to become regulated.
- We propose a capital regulation policy that considers this strategic behavior.
- The policy is shown to be procyclical (opposite of the counter-cyclical policy proposed in literature).
- The proposed policy is macro-prudential, market-based (self-stabilizing) and robust to small measurement errors.
- Procyclicality of the capital regulation policy survives even when one of the traditional forces that generate counter-cyclical policy — evolving bank capital — is present.

Shortcomings/Extensions

- What if σ varies?
- Some of the features of our policy rely on the sharp condition of indifference.
- Endogenize asset return distribution.